POSITIVE UNCERTAINTY EFFECTS OF NEAR-TERM CLIMATE POLICY RECOMMENDATIONS

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Overview

How does risk and uncertainty in climate thresholds impact the optimal policy? For a while, the integrated assessment community has struggled to determine this so called *uncertainty effect* on the near-term carbon abatement trajectory. Among other concerns, many studies overlook the relevance of nonanticipativity and time-consistency principles when applying stochastic frameworks to climate policy, which can often lead to determining the wrong sign, if not the wrong magnitude, of the uncertainty effect. To address such issues, I provide a nonanticipative stochastic program based on the DICE model [Nordhaus and Sztorc, 2013], which relies on the transparency of mathematical programming.

The model shows that the incentive for precautionary abatement is robust, in assessing emissions abatement as a means to minimize the risk of catastrophic events. In light of well-founded axiomatic models of intermtemporal utility applied in dynamic programming, I integrate a dynamically consistent form of risk and ambiguity aversion, to further outline the possibilities of a positive uncertainty effect. Overall, the methodology outlined in this research contributes to the assessment of uncertain climate damages, especially for large climate-economy models that have difficulty applying recursive optimization methods.

Methods

This short methodology paper demonstrates the application of stochastic programming to climate IAMs to assess the uncertainty effects of near-term climate policies. For results, the model employs multistage stochastic programming with recourse; stochastic control; risk-averse stochastic programming; and distributionally robust stochastic programming.

Results

The model output outlines factors that contribute to a strong *positive* uncertainty effect on emissions abatement. By taking into account the risk of climate thresholds in an act-then learn framework, near-term abatement levels increase substantially, driven largely by precautionary incentives to decrease the future likelihood of climate tipping. A time-consistent application of risk aversion further strengthens this effect. Lastly, distributional comparative statics suggest that optimal prescriptions based on insufficient knowledge of the tipping point probability distribution may have difficulty agreeing on magnitude. *Distributionally robust* stochastic programming demonstrates further increases in near-term abatement, induced by aversion to Knightian uncertainty (model ambiguity).

Conclusions

A Bayesian approach to learning in an *act-then learn* framework is powerful, as it captures the sequential process of decision making under uncertainty based on *new observational evidence*. In an act-then learn stochastic control framework, I show that the possibility of climate tipping in the future considerably increases optimal abatement to delay or even avoid the occurrence of threshold damages. Distributional sensitivity analyses nevertheless expose the near-term optimal policy's dependency on the Bayesian prior. This is discomforting as it seems that even the most minimal of frameworks inevitably suffer from the pitfalls in Bayesian learning. Large variability in model induced priors, that cannot be ranked nor aggregated due to difficulty in quantifying relationships among distributions, poses a problem of distributional ambiguity. By applying distributionally robust stochastic control, a solution to the ambiguity problem that hedges against the worst expected outcome from a set of permissible distributions, I devise a conservative policy that reflects aversion towards risk and uncertainty. The paper numerically shows that aversion to risk and ambiguity brings about an additional increase in near-term abatement, to further strengthen the potential of a positive uncertainty effect.

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